Agenda

Time			
		DAY ONE	
Noon - 1 PM	Registration for conference		
1:00 PM	Safety instructions/opening announcements		
1:15 PM	Welcome- Scott Hubbard ARC Center Director		
1:45PM	Keynote speaker: Dr. Christopher D. Wickens, Professor of Psychology, Head: Aviation Research Lab, University of Illinois @ Urbana-Champaign;Institute of Aviation.	History, present, and future trends of aviation human factors.	
3PM	Patricia Jones, Acting Chief , Ames Human Factors Reseaarch and Technology Division	HF in Aeronautics/HF Division Work	
3:45	**Break**		
4PM	Richard Mogford PhD., Manager, Human Measures and Performance Project & Symposium Chair	Introduction to Symposium	
5:00PM	HFS closes for the day		
		DAY TWO	
3 concurrent sessions:	**—User interface deisgn tools, guidelines, techniques and lessons learned**	**—Human performance issues in complex systems**	**—Fundamental research in human factors**
Opens @ 8	Contential Breakfast for those who purchased	Contential Breakfast for those who purchased	Contential Breakfast for those who purchased
8:30-9:30	DeMaio, Joe: An Evaluation Methodology for Traffic Awareness Displays	Bixler, Jeff: ASRS/PSRS/SIMS/ASAP Reporting	Barhydt, Richard: AOP Human Factors Design Considerateions, Flight Crew Interface & Pilot's use of the system in the context of current and future operating environments
9:30-10:30	Arend, Larry: Quality Assurance for Aviation Information Display	Degani, Asaf: Analysis and verification of Procedures for System Recovery	Ellis, Steve: Augmented Reality Tower tool (ARTT) in a Simulated Tower Environment: Effect of field of View on Aircraft Detection
10:30-11:30	Szoboszlay, Zoltan: Flight Path Marker Symbol for Rotorcraft Synthetic Vision Displays	Burian, Barbara: Emergency and Abnormal Checklist Design Factors Influencing Flight Crew response: A Case Study	Adelstein, Bernard: Measuring & Managing Human Response to Latency in Immersing Head-Mounted Display (ie VE) Systems
11:30- 12:30	Corker, Kevin & Foyle, David: SVS Operator Modeling	Sherry, Lance: Analysis of the Human-Computer Interaction for Scratchpad Error Messages on the Flight Management System	Begault, Durand: Intelligibility in Auditory Displays
12:30 -1:30	**Lunch**	**Lunch**	**Lunch**
1:30-2:30	Muthard, Emily: An evaluation of hazard surveillance and flight control with displays of varying magnitudes	Connors, Mary: National Aviation Operations Monitoring Service (NAOMS)	Ruthruff, Eric: Enabling Efficient Human Multi-tasking
2:30-2:45	**Break**	**Break**	**Break**
2:45-3:45	Kaiser, Mary & Sweet, Barbara: Modeling Pilots' Use of Visual Cues for Active Control	Smith, Nancy: A Human in the Loop Simulation Assessment of an En Route Trajectory Negotiation Concept	Mulligan, Jeff: Taking Eye-Tracking from the lab to the field (& sky)-Presents results from FAA helicopter flight study.Incorporating material from FFC tower study
3:45-4:45	Johnson, Walter & Bilimoria, Karl: Comparison of Pilot & Automation Generated Conflict Resolutions	Nowinski, Jessica: Cognitive Errors in the Cockpit	Wenzel, Elizabeth: Current Approaches to 3-D Sound Reproduction
		DAY THREE	
			HUMAN Performance in Complex Systems:
8:30-9:30	Feary, Mike: User interface evaluation - Dynamic Storyboard	Callantine, Todd: Simulation of Air Traffic Controller and Automation Performance	Dudley-Rowley, Marilyn & Cohen, Marc: NASA-Rockwell Space Station Crew Safety Study: Results from MIR
9:30-10:30	Schutte, Paul: Function Allocation and Operator Engagement	Lee, Paul: Effect of Increased Traffic Controller Workload	Foyle, David, Hooey Becky, & Wilson John: HUD Sympology: Command Guidance vs Situation Guidance
10:30-11:30	10:30-11 Dowell, Susan: Human Factors Issues in US Army Shadow UAV Systems	Johnson, Walter: A Simulation Evaluation of a Human Centered Approach to Flight Deck Procedures and Automation for En Route Maneuvering	Welch, Daniel: Effects of Procurement Type on Human Factors Activities
11:30-12:30	11:00-12 Hobbs, Alan: Understanding maintenance error	Tollinger, Irene & Connors, Chris: Anomoly Resloution	Hart, Sandy: MIDAS-structural augmentations
12:30-1:30	**Lunch**	**Lunch**	**Lunch**
1:30-2:30	Battiste, Vern: Human Centered Decision Support Tools for Arrival Merging and Spacing	1:30 PM - McCandless, Jeffrey: Development and Evaluation of Space Shuttle Cockpit Displays 2 PM - McCann, Rob: A human-centered operational concept for active fault management in next-generation space vehicles	Dorighi, Nancy: Ames' SimLabs Captures Pilot & Controller Perspectives via Integrated Simulation
2:30-2:45	**Break**	**Break**	**Break**
2:45-3:45	Watson, Andrew & Ahumada, Albert J Jr.: The Spatial Standard Observer and Aeronautical Applications	Casner, Steve: The effects GPS and moving map displays on pilot navigational awareness.	REDUCING PILOT ERROR: From Basic Research to Operational Procedure. Dismukes, Key: Basic & Field Research on Concurrent Task Mangement
3:45-4:45	Meyer, George: Conflict Resolution in multi-agent systems	Matessa, Mike: Human Performance Modeling work in Implementing CPM-GOMS Templates and Interleaving theroy in ACT-R	Barshi, Immanuel: Applications to Operating Procedures
		DAY FOUR	
		Lab, Facility Tours	
		Assemble in Building 262 in Room 100	

Measuring and Managing Human Response to Latency in Immersing Head-Mounted Display (i.e., VE) Systems

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ABSTRACT

In general, excessive time delay (latency) in aeronautic and other types of interactive real-time simulations can hinder both perceived realism and resultant human performance. In the case of head-borne virtual-environment (VE) simulators, temporal dynamic fidelity requirements are among the most stringent. In particular, such time delays, which are due to data transport and computer processing from head-motion transduction through until the graphical consequences of the motion are rendered in a head-mounted display, can make the surrounding virtual scene appear to swim and drift with respect to the user. This loss of visual spatial stability is thought to be a major contributor to motion- or simulator-sickness in interactive, immersive simulations.

In this presentation, we will review scientific and engineering accomplishments from activities in the Advanced Displays and Spatial Perception Laboratory at NASA-Ames that have been directed at mitigating the effects of VE simulation latency on user performance. The following facets of our work will be discussed: psychophysical measurement of human perceptual tolerance to VE simulation latency; modeling latency perception mechanisms; and application of this knowledge in the design and implementation of VE latency management strategies.

Quality Assurance for Aviation Information Display

Larry Arend
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ABSTRACT

Aviation information displays require some form of quality assurance due to public safety concerns. The color design methodologies, standards, and guidelines employed in the past are insufficient to guide design of current information displays, which have reached map-like complexity. For these more complicated designs quality assurance needs to focus on performance in context rather than individual graphic elements. We are researching web-based color-guidance tools to help advance the design and review processes. Current web technologies allow us to demonstrate the performance issues that guidance statements address in the context of a hyperlinked network of supporting information at varying levels of technical detail.

ACKNOWLEDGEMENTS

This research was sponsored by the NASA Human Measures and Performance Project.

AOP Human Factors Design Considerations, Flight Crew Interface and Pilot's use of the System in the Context of Current and Future Operating Environments

Richard Barhydt, NASA Langley

ABSTRACT

NASA Langley has developed a multi-mode decision support system for pilots operating in a Distributed Air-Ground Traffic Management (DAG-TM) environment. An Autonomous Operations Planner (AOP) assists pilots in performing separation assurance functions, including conflict detection, prevention, and resolution. Ongoing AOP design has been based on a comprehensive human factors analysis and evaluation results from previous human-in-the-loop experiments with airline pilot test subjects. AOP considers complex flight mode interactions and provides flight guidance to pilots consistent with the current aircraft control state. Pilots communicate goals to AOP by setting system preferences and actively probing potential trajectories for conflicts. To minimize training requirements and improve operational use, AOP design leverages existing alerting philosophies, displays, and crew interfaces common on commercial aircraft. Future work will consider trajectory prediction uncertainties, integration with the TCAS collision avoidance system, and will incorporate enhancements based on a recently completed air-ground coordination experiment.

The presentation will discuss the AOP human factors design considerations, flight crew interface, and pilot's use of the system in the context of current and future operating environments.

Reducing Pilot Error: Applications to Operating Procedures

Immanuel Barshi

ABSTRACT

A discussion of the ways in which the basic and field research described in Key Dismukes' talk "Reducing Pilot Error: Basic Research to Operational Procedures," have been implemented in airline procedures for normal operations.

Human Centered Decision Support Tools for Arrival Merging and Spacing

Vernol Battiste, Walter W. Johnson, Stacie Granada,
Nancy H. Johnson, and Arik Quang V. Dao

ABSTRACT

At the core of the concept of Distributed Air-Ground Traffic Management is the idea that National Airspace System (NAS) participants can be information suppliers and team members who collaborate at all levels of traffic management decision making. One such concept, and the focus of this paper is Concept Element 11 (Terminal Arrival Self-Spacing for Merging and in-Trail Separation). The objective of CE 11 is to minimize the in-trail spacing buffers between terminal area arriving aircraft flying under instrument meteorological conditions (IMC). CE 11 utilizes time-based in-trail spacing to take advantage of the natural spacing compression as aircraft decelerate in preparation for landing. To support the transition of responsibility for maintaining the desired spacing interval from the controller to the flight crew, advanced ATM technologies were developed. The flight deck display tools enable operators to safely and efficiently perform the necessary spacing tasks essential to the success of the concept. In this report we will focus only on the development and evaluation of the flight deck decision support tools (DST). The cockpit situation display (CSD), which includes the cockpit display of traffic information (CDTI) is the primary focus of our research and has been identified as the primary flight DST for enhancing situation and traffic awareness. Thus, we integrating the spacing cues derived from the spacing algorithms into the CSD. This paper examined the feasibility of the merging and self-spacing concepts from the flight deck perspective under mixed traffic conditions, where only some of the aircraft were equipped for self-spacing and merging. Nine air transport and/or commercial rated pilots and four controllers participated in a study to evaluate the CE-11 concept. Four experimental conditions were created to examine pilot and controller performance: No Tools, Ground Tools only, Air Tools only, and Air & Ground Tools. Data was collected from thirty-two runs, eight runs per condition. To assess the operational feasibility of the concept from the flight deck perspective the following items were assessed: safety, usability and usefulness, assigned spacing interval vs. achieved, inter-arrival spacing, and flight crew workload. Some safety issues concerning self-spacing were noted by pilots and controllers: aircraft handed off to final controller at slow speeds reduces the options that a controller has to manage the spacing interval between aircraft, and self-spacing aircraft tended to engage in more speed changes than is typical during final approach, thus making it more difficult to manage non-self-spacing aircraft. Pilots reported that the frequency and amplitude of speed changes that occurred while spacing were a major concern. They felt that the activation of the spacing tool resulted in too much throttle movement that could potentially cause passenger discomfort and increased fuel consumption. They also suggested that the system should cue the flight crew when flap settings need to be changed to achieve the commanded speed. Pilots also recommended that the algorithms be designed to initiate speed changes sooner, but more gradually. They also suggested the system should deliver speed changes similar to the way controllers do today: reducing the speed of the aircraft as it approaches the airport and rarely increasing the speed after slower speeds have been assigned. Pilots consistently rated the flight deck tools favorably in terms of usability, usefulness, and situation awareness. Other recommendations referred to the display of aircraft type and geographical information on the traffic display. Results showed no significant differences in inter-arrival spacing precision between conditions - air and ground tools. Generally, pilot and controller workload ratings were moderately low. Workload differences between conditions were relatively small for pilots. The lack of favorable performance results for time-based spacing operations should not be interpreted as limitations or

shortcomings of the concept. The results are more indicative of the stage of development for the tools and procedures. Based on controller and flight crew comments and also their interactions with the tools and procedures, the concept of merging and self-spacing during arrival and approach seems feasible.

Intelligibility in Auditory Displays

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ABSTRACT

The design of an auditory display is crucial for safe and efficient operations conducted in a high-stress human-machine environment, for example, in an aircraft flight deck or in a virtual environment teleoperation activity. The binaural hearing system's advantage over one-ear listening can be demonstrated not only in a laboratory context but also in practical applications for improving auditory intelligibility. Although these operational environments are necessarily dependent on intelligibility measures for determining the quality of speech communications, there are other criteria that can be equally important for assessing, measuring or predicting an improved auditory display design. These criteria apply not only to speech communications but also to other auditory or multi-modal forms of information related to the operational state of the machine. Evaluation of the auditory display may be conducted in terms of measurement and evaluation of human performance, in terms of error rates; time for task completion; discriminability between simultaneous streams of information; recognizability; and reaction time. Evaluation of perceived quality may also be germane. Human performance within the display can in turn be predicted by evaluating distortion levels, spectrum of masking background noise, and the configuration in perceived auditory space of multiple information streams Examples of applications and research pertinent to auditory display design at the Spatial Auditory Display laboratory at NASA Ames Research Center will be given

ASRS / PSRS / SIMS / ASAP Reporting

Jeff Bixler, ASRS Deputy Director and Linda Connell, ASRS Director

ABSTRACT

The Aviation Safety Reporting System (ASRS) was established in 1976 following a tragic accident near the Dulles Airport. The Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) collaborate to provide this cooperative safety program to the aviation community. The ASRS invites pilots, air traffic controllers, flight attendants, maintenance personnel, and others to voluntarily report to NASA any actual or potential hazard to safe operations. Since its inception, the ASRS has received over 631,000 reports and continues to be successful because of the program's steadfast principles of voluntary submission, confidentiality, and non-punitive protections.

The ASRS content includes a report narrative, which uniquely describes the reporter's role in "why" an incident occurred and not just the "what". This information provides insight into the human's involvement in complex systems, such as aviation. Numerous human factors projects have found the ASRS information to be indispensable in understanding human interfaces to the aviation system, such as issues of decision making, communication, automation, etc.

Recognition of the value of ASRS information is evident through the many cross-industry applications currently being developed in other domains. Both international and domestic government and non-government entities involved in transportation, medicine, and security have begun to develop reporting systems based largely on the ASRS model. NASA and the ASRS have helped play a key role in expanding these domains understanding with the creation of the Patient Safety Reporting System (PSRS) and the Security Incident Reporting System (SIRS). The future evolution of ASRS is progressing and will continue to be a valuable source of information for the human factor and research communities.

Emergency and Abnormal Checklist Design Factors Influencing Flight Crew Response: A Case Study

Barbara Burian

ABSTRACT

There are a number of different factors that go into the design of emergency and abnormal checklists. How these factors may relate to checklist use and errors made when completing checklists is often under-appreciated. A variety of checklist design features will be discussed with an emphasis on those that may have influenced a flight crew's checklist use in response to an in-flight fire.

Simulation of Air Traffic Controller and Automation Performance

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ABSTRACT

Air traffic control automation that complements flight deck automation holds promise for more efficient, economical, safe, and secure air traffic management (ATM). For example, NASA Ames researchers are developing air traffic control tools that enable controllers to more consistently issue strategic clearances, in turn enabling airlines to realize greater benefits from aircraft flight management systems. Modeling and simulating air traffic controller performance together with new automation can help researchers visualize traffic flows and assess how the proposed controller tools impact the safety and robustness of the ATM system.

This presentation describes integrated air traffic controller and automation simulations developed to inform ATM research. Of particular interest are simulation-based methods for identifying and evaluating strategies for using new air traffic control tools, and for characterizing operational contexts that warrant detailed studies with qualified practitioners. The presentation focuses on air traffic controller models, and describes computational models that include situation assessment, control strategy selection, planning, and clearance formulation—in addition to controller-controller coordination and the transfer of control of aircraft. After describing results from previous simulations, the presentation discusses requirements for improved air traffic controller models capable of simulating key controller behaviors. Among the requirements are capabilities to focus on troublesome aircraft, to formulate relatively easy clearances to fly, to establish predictable patterns and issue consistent instructions to successive aircraft, and to revert to tactical control from automation-supported strategic control when the situation dictates. The presentation suggests model enhancements to support these capabilities.

National Aviation Operations Monitoring Service (NAOMS)

Mary Connors and Linda Connell

ABSTRACT

Although a number of valuable sources of aviation safety data currently exist, most are limited in scope, while others, although broad in scope, are not quantifiable. A goal of the Aviation Safety and Security Program (AvSSP) is to reduce accidents. To know whether actions taken to improve safety are effective, one must be able to measure safety trends over the near- and long-term. The National Aviation Operations Monitoring Service (NAOMS) has been designed to address this need for quantifiable information on the state of the national airspace system (NAS).

NAOMS examines the NAS through the eyes of the end users. It is designed to survey operators of the NAS (i.e., pilots, controllers, mechanics, flight attendants and others) on a regular basis using a carefully-crafted instrument in accordance with established research protocols. This presentation will outline the background, goals, approach, and implementation of the NAOMS, describe in general terms outcomes of the investigation to date, and discuss the future application of the NAOMS approach.

SVS Operator Modeling

Kevin Corker (SJSU) and David Foyle (NASA)
Funded by AvSSP/SWAP Human Performance Modeling (HPM) element
Presenters: Corker and Foyle

ABSTRACT

In the first part of this paper, an overview is provided of the Human Performance Modeling (HPM) project within NASA's Aviation Safety and Security Program (AvSSP). The overall goal of the HPM project is to develop and demonstrate cognitive models of human performance that will aid aviation product designers in developing equipment and procedures that are easier to use and less susceptible to error. A series of approach and landing scenarios were flown in a part-task simulation facility in the Human-Centered Systems Laboratory at NASA Ames Research Center by commercial-rated pilots to collect nominal data which would characterize pilot performance during the approach and landing phase of flight using conventional and augmented displays under IMC and VMC weather conditions. Five modeling frameworks have been extended to this complex problem of modeling pilot behaviors during approach and landing operations with and without the availability of a synthetic vision system (SVS) display. In the second part of this paper, San Jose State University's Human Performance Human Automation Integration Laboratory (HAIL) effort to develop human models to predict the performance of operators using the SVS will be described. The standard Air MIDAS model of visual performance (Corker, 2000) was augmented to simulate pilot's monitoring of instrument and out-the-window scanning while on approach to landing. An aircraft dynamic simulation model PC Plane, was integrated into the human-system model in order that Air MIDAS operators would be controlling aircraft performance under realistic temporal constraints. Test scenarios for the simulation were developed and procedures were established based on established cockpit procedures for a current aircraft. Simulation runs were performed under several conditions: approach & landing, and go around both with “current day” technologies or SVS cockpit configurations. Simulation results suggest that SVS use might cause small delays initiating several cockpit tasks, however, its use did not provide any issues with respect to flight safety during normal approach, landing and go around flight phase. The SVS does offer approach and landing support in all-weather conditions and support in approach to “non-instrumented” airports.

Analysis and Verifications of Procedures for System Recovery

Asaf Degani

ABSTRACT

Procedures constitute conditional instruction sequences for user interaction with a given system. Their aim is to guide the user in operating the system correctly, reliably, and, most of all, safely. Procedures are generally deployed in operation of complex and high-risk systems such as nuclear power, medical systems, military operations, and air and space flight operations. Of special importance are procedures for abnormal and emergency situations, where the timing of executions is essential.

Current approaches and practice for designing procedures are based on utilizing the experience and expertise of system designers and users, in order to collectively formulate the „best‰ way(s) for achieving specified operational goals (e.g., securing the engine following a fire). The increasing complexity of the underlying systems and the growing reliance on automation make this approach progressively more difficult to employ.

To overcome some of the above mentioned difficulties, we propose a formal approach for systematic construction and verification of procedures. In this approach we employ formal mathematical methods, based on detailed models and descriptions of the system and its operational specifications. Our modeling framework for describing the system behavior and possible human interaction with it currently consists of the state machine formalism. The cornerstone of our analytical approach is the recognition that there are three major steps in dealing with an emergency situation: *imperative blocking* of possible transgressions into catastrophic states, *preliminary stabilization* of the system, and *measured steps* to recovery. Moreover, in the face of an unpredictable environment or when only partial information about the system is available so that full recovery cannot be guaranteed, graded recovery must be addressed and formulated. The corresponding recovery or emergency procedures are then computed by systematically creating optimal contingency paths for recovery.

An Evaluation Methodology for Traffic Awareness Displays

Joe De Maio and Munro Dearing

ABSTRACT

An evaluation methodology for traffic awareness displays for helicopters and other vertical/short takeoff aircraft was developed. Pilots of vertical/short takeoff aircraft will require more traffic information than would pilots of conventional aircraft to avoid both other vertical/short takeoff traffic and conventional traffic. The BF Goodrich Skywatch® traffic advisory display was used as a candidate display to develop a procedure for evaluating the usefulness of such displays. Four high-time helicopter pilots participated in a 16-hour flight evaluation. They flew a closed circuit in the San Francisco Bay Area. In one-half of the flights the evaluation pilot had the traffic advisory display as an aid in detecting and locating traffic. In the other half of the flights the traffic advisory display was not available to the evaluation pilot. Data examined include measures of traffic advisory display performance and pilot performance in detecting traffic, as well as subjective workload and situation awareness data. The traffic advisory system did not help the pilots to detect more traffic. The importance of detection to traffic awareness is discussed.

Reducing Pilot Error:
Basic and Field Research on Concurrent Task Management

Key Dismukes

ABSTRACT

Forgetting to perform intended tasks has contributed to several major airline accidents and frequently contributes to delays and additional operating costs. Our research group is conducting a multi-prong approach to study prospective memory (remembering to perform intended actions). We conduct laboratory experiments and theoretical analyses to investigate the cognitive mechanisms underlying prospective memory and to elucidate the ways in which those mechanisms are vulnerable to error. We also conduct field studies to determine the nature of task demands involving prospective memory in operational situations and to identify the types of error most commonly made and the consequences of those errors. The laboratory/theoretical work and the field studies inform and complement each other, and both are necessary to develop powerful countermeasures against human error. For example, we recently completed a cockpit jumpseat study of the concurrent task demands in routine airline operations. We found that pilots frequently must juggle several tasks concurrently, that interruptions and distractions are frequent, and that operational circumstances not infrequently force crews to perform tasks out of the normal sequence prescribed in operating manuals. All of these situations impose prospective memory demands--while performing one task another must be deferred--and errors are not uncommon. Our laboratory/theoretical studies are providing an account for why those errors occur and are laying a foundation for countermeasures to reduce vulnerability to error.

Ames' SimLabs Captures Pilot and Controller Perspectives via Integrated Simulation

Nancy Dorighi

ABSTRACT

Aviation human factors research is, by nature, complex due to the many players involved in air transportation operations. Every perturbation of the National Airspace System (NAS), such as a new technology or procedure, touches pilots, air traffic controllers and airport operators. NASA Ames SimLabs offers a unique suite of integrated, high fidelity simulators for investigating aviation research questions simultaneously from the pilot and the controller perspectives. The air traffic control (ATC) facilities encompass all domains, including tower, terminal area radar control (TRACON) and en route, to mimic the real-world hand-off of communication and control from one facility to the other. The flight simulation facilities offer various vehicle and cockpit configurations, including commercial transports, future advanced aircraft and high performance vehicles. These high fidelity motion-based cockpits provide full mission environments and tools to effectively analyze flight crew performance. Field testing of new concepts is expensive, risky, and restrictive. Together, the SimLabs facilities represent an unparalleled resource for researchers to comprehensively and efficiently evaluate concepts in terms of human performance, and their effect on aviation safety and capacity. The briefing will elaborate on the capabilities of each facility and present a case study in which both pilots and controllers experienced together a future airport initiative.

Human Factors Issues in US Army Shadow UAV Systems

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ABSTRACT

In an attempt to increase knowledge of nominal UAV missions, operator tasks, and GCS displays, unclassified portions of UAV operator training were attended at the US Army UAV Operator Training Center, Ft. Huachuca, AZ. Utilizing the US Army's Tactical UAV as a baseline, Army/NASA Rotorcraft Division designed an emulation of the Shadow Ground Control Station (GCS). This presentation will offer a broad overview of operator-interface issues unique to UAV control and operations. Specifically, Shadow 200 UAV operations Mission Planning Operator (MPO) and Aerial Vehicle Operator (AVO) display interfaces will be presented and noted for potential research and design opportunities with applied Human Factors design principles. Research topics will include: 1) redesigned payload symbology (overlays) 2) potential capabilities for HMD control of sensor payload, and 3) single operator control of one or multiple UAVs. Lastly, future research direction will be outlined, including control of multiple vehicles with varying levels of automation.

NASA-Rockwell Space Station
Crew Safety Study: Results from MIR

Marilyn Dudley-Rowley, Ph.D., Marc M. Cohen, Arch.D.* Pablo Flores**

Sociology Department, Sonoma State University Advanced Projects Branch,
NASA-Ames Research Center*
Moscow Aviation Technical Institute**

ABSTRACT

In 1985, Rockwell International (now Boeing-North American) completed the Space Station Crew Safety Alternatives Study for NASA. This five-volume study identified a wide range of potential safety threats and hazards that the crew might encounter on the future International Space Station. These threats included fire, explosion, collision, decompression, contamination, and radiation, among many others. One volume focused on the human factors aspects of safety, featuring the Crew Safety-Human Factors Interaction Model. In this model, a stressor (such as one of the threats) can lead to degraded performance, which can contribute to human error, unless appropriate and effective countermeasures are available to the crew.
In 1986, the Soviet Union launched the Mir Space Station, the ?second generation? that followed the Salyut series of space stations. The Mir was designed for a five year life on orbit. It remained in use for fourteen years. During the first ten years, it performed well, with few safety issues. However, during the last four years, the aging station -- operating at more than two times beyond its design lifetime -- encountered a variety of safety hazards and human factors issues. Despite these often serious problems, the Mir crews always found a way to save the station, and no crew member was seriously injured or killed.

This paper evaluates the safety record on Mir, and compares it to the NASA-Rockwell study, that was contemporaneous with the construction and launch of Mir. This comparison and analysis can provide a foundation for future space crew safety and related human factors support.

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Augmented Reality Tower Tool (ARTT) in a Simulated Tower Environment: Effect of Field of View on Aircraft Detection

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ABSTRACT

An optical see-through, augmented reality display was used to study subjects' ability to detect aircraft maneuvering and landing at the Dallas Ft. Worth International airport in an ATC Tower simulation. Subjects monitored the traffic patterns as if from the airport's western control tower. Three binocular fields of view (14°, 28° and 47°) were studied in an independent groups' design to measure the degradation in detection performance associated with the visual field restrictions. In a second experiment the 14° and 28° fields were presented either with 100% binocular overlap or 46% overlap for separate groups. The near asymptotic results of the first experiment suggest that binocular fields of view much greater than 47% are unlikely to dramatically improve performance; and those of the second experiment, that partial binocular overlap is feasible for augmented reality displays such as may be used for ATC tower applications.

User Interface Evaluation – Dynamic Storyboard

Mike Feary

ABSTRACT

Modern engineering design processes often validate user-device interaction via paper-based validations or a software prototype of the product. Paper-based evaluations, such as storyboards and walkthroughs, produce relatively quick and inexpensive evaluations, but they provide a limited view of user interaction. In contrast, traditional software prototypes which allow demonstration of a properly working device in software form provide a means to validate the product design over a significantly larger subset of the user-device interaction space than static storyboards. However, software prototypes can be expensive and time intensive to build, resulting in greater inertia to overcome to effect design changes.

In response to an industry request, an approach was taken to remedy this problem in the form of a new type of software application for user-interface evaluation. This paper describes the new software application that combines the speed of static storyboard development with the increased interaction and range of activities offered by a traditional software prototype referred to as a Dynamic Storyboard. The paper describes the Dynamic Storyboard, its underlying components and provides an example of use for aircraft automation user interface evaluation.

HUD Symbology: Command Guidance vs. Situation Guidance

David Foyle (NASA), Becky Hooey (SJSU) and John Wilson (SJSU)
Funded by AS/HMP/HADMT
Presenter: Foyle

ABSTRACT

This study investigated pilots' taxi performance, situation awareness and workload while taxiing at a simulated DFW airport with three different head-up display (HUD) symbology formats: Command-guidance, Situation-guidance and Hybrid. Command-guidance symbology provided the pilot with required control inputs to maintain centerline position; Situation-guidance symbology provided conformal, scene-linked navigation information; while the Hybrid symbology combined elements of both symbologies. Taxi speed, centerline tracking accuracy, workload and situation awareness were assessed. Taxi speed, centerline accuracy, and situation awareness were highest and workload lowest with Situation-guidance and Hybrid symbologies. These results are thought to be due to cognitive tunneling induced by the Command-guidance symbology. The conformal route information of the Situation-guidance and Hybrid HUD formats provided a common reference with the environment, which may have supported better distribution of attention. Additionally, implications of pilot interviews regarding the format of displays for 4-D surface navigation (time-based clearances) will be discussed.

MIDAS – Structural Augmentations

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ABSTRACT

The Man-machine Integration Design and Analysis System (MIDAS) is one of the earliest and most complete computational Human Performance Models. However, it has undergone significant changes in recent months. The history of MIDAS as well as its current status will be described and demonstrated. MIDAS now runs on a high-end PC, the code has been re-written in C++, and complementary models have either been incorporated (to simulate the impact of fatigue on performance) or linked (Apex) to enhance its capabilities. The impact of performance modifying factors (e.g., gravitational effects) on predicted workload, situation awareness, the timing of ongoing procedures and the likelihood of errors are computed and presented graphically and as a dynamic animation.

Comparison of Pilot and Automation Generated Conflict Resolutions

Walter W. Johnson,[✪] Karl D. Bilimoria,[★] Lisa C. Thomas,[‡]
Hilda Q. Lee,[†] and Vernol Battiste[✣]

ABSTRACT

This study compares and contrasts conflict resolutions as performed by pilots with and without a resolution decision support tool, and a fully automated conflict resolution tool that generates optimal (smallest path deviation) resolutions. The conflict geometries investigated were all factorial combinations of three levels of intruder aircraft speed, three levels of initial Ownship distance to minimum separation, and nine conflict angles. The resolution decision support tools included dynamic conflict alerting, which indicated whether a proposed path was conflict free, and a dynamic predictor system that showed a fast time depiction of the proposed resolution trajectories. The automation-generated resolutions, computed using a geometric optimization algorithm, served as a benchmark against which the pilot-generated resolutions were compared. Without decision support tools the pilot-generated resolutions were often ineffective, particularly at lower conflict angles. The resolutions tended to be effective when the decision support tools were used. Resolution cost, as measured by added path length, was greater for pilot-generated resolutions (averaging 2.7 nm) compared to the automation-generated resolutions (averaging 1.2 nm). When pilots had the decision support tools, their strategies, as indexed by whether they turned towards or away from the intruder, tended to be opposite that of the automated system.

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Effect of Increased Traffic on Controller Workload

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ABSTRACT

Controller workload has been a focal topic in air traffic management research because it is considered to be a key limiting factor to capacity increase in air traffic operations. Past research has shown that the aircraft count is one of the best indicators of controller workload. Despite a well-established correlation between workload and traffic count, the nature of the relationship has not been well characterized. An interesting phenomenon from past simulations at NASA Ames Research Center has been that the controllers would give relatively low workload ratings for seemingly busy traffic problems. Various factors (e.g. bias in subjective ratings) contribute to these low ratings, but one main factor could be that a controller *perceives* the workload to be low until the traffic and associated task load increase to reach a critical point. From this point, the workload increases much faster with each added task. In a series of informal studies conducted as a precursor to testing DAG-TM concepts, we manipulated aircraft count in real-time human-in-the-loop simulations to determine critical traffic levels at which the controllers stated that traffic would be no longer manageable. As hypothesized, the workload increased gradually at moderate levels of traffic but the traffic quickly became unmanageable when only a few aircraft were added to the critical traffic level. Feedback from the controllers further supported the non-linear nature of subjective workload. They underlined the importance to proactive monitor the critical traffic level, which may vary depending on situational factors, such as controller's ability, traffic complexity, off-nominal events, etc.

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A Simulation Evaluation of a Human-Centered Approach to Flight Deck Procedures and Automation for En Route Free Maneuvering

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Stacie Granada, Nancy Johnson, and Quang Dao
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ABSTRACT

In June 2004, research teams at the NASA Langley Research Center and Ames Research Center conducted a joint human-in-the-loop experiment investigating the feasibility and operational benefits of one Concept Element (CE) under consideration as part of the Distributed Air-Ground Traffic Management (DAG-TM) program: *CE 5 En Route Free Maneuvering*. The work was completed as part of the Advanced Air Transportation Technologies (AATT) project under NASA's Airspace Systems program. The experiment represented a continuation of previous studies at both centers. This report presents only data on the performance of the flight deck element at the Ames Research Center.

The experimental data addresses safety and feasibility related to two primary areas: mixed operations and scalability. Mixed Operations refers to the feasibility of conducting operations with autonomous and managed aircraft in the same airspace. Scalability addresses the ability of en route capacity to dynamically accommodate substantial increases in traffic volume through the increase of autonomous aircraft. To achieve scalability, the interactions between autonomous aircraft and the ATSP must be minimized or designed in ways that do not negatively impact controller workload.

The airside performance data from the single-pilot Ames AFR stations support the safety and feasibility of the concept. Failures by these stations to conform to the requirements of the concept were very rare, and largely due to remaining bugs in the CD&R software.
In addition, pilot comments suggested that the concept is feasible, with pilots indicating their willingness and ability to accept the additional responsibilities, and also indicating that the workload was well within bounds of acceptability.

Understanding Maintenance Error

Alan Hobbs and Barbara Kanki

ABSTRACT

Although recent accidents have implicated maintenance as their root cause (e.g. Air Midwest at Charlotte, NC, in January 2003) maintenance human factors remains a relatively unexplored research domain. The nature of maintenance error contributes to its lack of visibility. Maintenance errors can remain latent for significant periods of time before an accident or incident occurs, and the circumstances surrounding each error may be difficult to establish. . Yet a number of problem areas have been identified and the establishment of maintenance error databases have been initiated at both organization and industry levels.

Over the last 5 years, the NASA Aviation Safety and Security Program has sponsored a wide range of maintenance human factors research projects to build proactive solutions in response to some known problems. Basic topic areas include: 1) maintenance resource management (MRM) skills, training and evaluation, 2) task and risk assessment tools for improving processes, procedures and inspection reliability, and 3) the application of advanced displays using virtual reality and augmented reality technologies to enhance maintenance and inspection. Finally, we continue to improve our understanding of maintenance error by supporting and researching maintenance error data.

Confidential incident reports have the potential to reveal information on the risks of maintenance error. Crew Factors at NASA Ames has been examining maintenance incident reports submitted to the Aviation Safety Reporting System (ASRS). Recent studies have examined the issues of procedural errors, shift turnover, the use of minimum equipment lists (MELs), and associations between errors and incident circumstances. Implications for the management of human error risks are discussed.

Human Performance Modeling Work in Implementing CPM-GOMS Templates and Interleaving Theory in ACT-R

Mike Matessa

ABSTRACT

Human performance modeling has been made easier by architectures which package psychological theory for reuse at useful levels of abstraction. Two examples of these architectures are CPM-GOMS and ACT-R. CPM-GOMS uses templates of behavior to package at a task level (e.g., mouse move-click, typing) predictions of lower-level cognitive, perceptual, and motor resource use. Packaging at this level allows modelers to easily describe well-practiced procedures as lists of tasks to perform. ACT-R uses a production system architecture for packaging knowledge at the lower level of rules for working with cognitive and perceptual information and motor actions. This lower-level packaging allows ACT-R to have theories of memory and learning, but requires modelers to specify procedures with painstaking detail. This talk will describe ACT-Stitch, a framework for translating CPM-GOMS templates into ACT-R rules. This framework combines the usefulness of modeling at the task level with the process theory of a lower-level cognitive architecture. To create a model of a procedure, the modeler simply provides a list of tasks to perform. The tasks are compiled into ACT-R rules with a control structure that allows for interleaving between tasks (e.g., anticipatory eye movements for the next task while the current task is finishing). ACT-Stitch is used to make zero-parameter predictions in a well-practiced perceptual/motor task, and the interleaving theory is supported with results from an eye-tracking experiment.

A Human-centered Operational Concept for Active Fault Management in Next-generation Space Vehicles

Robert S. McCann, Ph.D., and Jeffrey McCandless, Ph.D.

ABSTRACT

In the current space transportation system, real-time vehicle health management is a collaborative activity between crewmembers and ground personnel. Active fault management is only automated to the extent that out-of-limit sensor values are flagged by the onboard caution and warning system and annunciated via alarms and fault messages. Beyond that, humans have full responsibility for diagnosing the problem and performing any relevant fault isolation and/or mitigation activities. In next-generation vehicles, vehicle health management will rely less on ground personnel and more on crew interaction with intelligent onboard software agents, such as data mining tools and model-based reasoners. A new health management operational concept is required that specifies modes of human-computer interaction and supporting human-computer interfaces. We describe a candidate concept for mixed human/machine fault management based on human-centered design criteria. The departure point for this concept is a set of upgraded shuttle cockpit displays and enhanced caution and warning system developed as part of the recent shuttle cockpit avionics upgrade program.

Development and Evaluation of Space Shuttle Cockpit Displays

Jeffrey McCandless, Ph.D.

ABSTRACT

The Cockpit Avionics Upgrade project was established in 1999 to update the display formats shown on the cockpit screens in the Space Shuttle. The goal of the project, based at NASA Johnson Space Center (JSC), was to increase safety by improving the crew's situation awareness, reducing their workload, and improving their performance. The display formats were redesigned through a collaborative effort including astronauts, flight controllers, instructors, engineers and human factors scientists.

As a means of determining the effectiveness of the revised displays, an evaluation was conducted in the motion-based Shuttle Mission Simulator at NASA JSC in 2003 and 2004. Eighteen astronauts participated in the evaluation. Minimum success criteria were established prior to the testing to provide a standard by which the updated displays would be evaluated. The minimum success criteria were: 1) improved situation awareness of vehicle trajectory and onboard systems, measured through subjective (opinion) scales and objective (right/wrong) questions, 2) reduced workload measured with the NASA Task Load Index and the Bedford Scale, and 3) increased performance indicated by crew malfunction recognition times and error rates. The evaluation data have been collected and all minimum success criteria were exceeded.

I will discuss the methodology used in this collaborative project to improve the shuttle cockpit displays, and I will present results quantifying the impacts of the upgrades.

Conflict Resolution in Multi-Agent Systems

George Meyer (NASA/ARC)

Joint work with: Stefan Resmerita (Johannes Kepler University)
and Michael Heymann (Technion)

ABSTRACT

A new model of multi-agent systems is presented. In the model, an agent is represented by a bundle of sequences of resources. For example, in air traffic management (ATM), a sequence represents a 4-D trajectory of an aircraft, a bundle represents as a discrete set of acceptable alternatives, and a resource represents a region of space-time of the airspace. A conflict arises when two or more agents compete for the same resource. The problem is how to resolve all the conflicts in a safe and fair manner. Straight forward application of Mixed Integer Linear Programming techniques leads to exponential complexity in number of agents and number of conflicts. An alternative that is of polynomial complexity is proposed in the paper.

Our approach takes advantage of the temporal consistency of the resources: if resource B follows resource A in one agent, it is so for all agents. It is then possible to construct priority functions over the conflicting resources, a rule of behavior for the (greedy) agents, and an algorithm that produces corresponding safe and maximal (Nash equilibrium) solutions in polynomial time. Extensions to other domains of application, such as remote labs, are discussed.

An Evaluation of Hazard Surveillance and Flight Control with Displays of Varying Magnitudes

Emily K. Muthard and Christopher D. Wickens

ABSTRACT

With competing pressures to minimize displays to fit within a cramped cockpit and to create large-scale panoramic displays that synthetically represent the out-the-window scene, the issue of display size is critical. Because displays are designed to support multiple tasks simultaneously, we review how size has been shown to affect several cockpit tasks, namely flight control, hazard surveillance, and target search. The presented review examines two means of manipulating display size in flight control, specifically altering the physical size of a two-dimensional display and compressing the axis along the line of sight within a three-dimensional display. With respect to flight control, the reviewed empirical findings suggest that displays with a larger scale lead to larger perceptions of control error and more urgent control maneuvers to correct the error, thus leading to superior control performance. The review also examines attention-based tasks with two-dimensional integrated hazard displays of different sizes. Empirical findings with regard to these tasks suggest that pilots are successful in strategically compensating for display enlargements in both surveillance and target search, performing equally well across display sizes. These findings have been mirrored in eye scanning data, showing that pilots allocate an equal proportion of attention to the outer display regions in displays of different magnitudes, despite the extra effort that must be employed to do so. The review concludes by hypothesizing how the reviewed empirical findings with respect to display size can extend to predict distance estimation from hazards in the airspace and resulting flight route selection.

Taking Eye-tracking from the lab to the field (and sky)

Jeffrey B. Mulligan

ABSTRACT

Gaze tracking measures can provide information about the spatial locus of attention of a behaving agent. Here we examine the looking behavior of helicopter pilots flying under visual meteorological conditions. The goal of the study is to correlate various types of looking behavior with pilots' accuracy in maintaining a precisely specified route, to support the formulation of new regulations and procedures. Eight pilots were instructed to fly a precision route specified by a series of waypoints. The geographic coordinates of the waypoints were entered into an onboard receiver of global positioning system (GPS) signals. Using a single 8mm videocassette, we recorded four video streams (30 frames per second), one audio stream, and GPS data sampled at 1 Hz. The four video streams were comprised of two cameras attached to the pilot's head, and two stationary cameras mounted on the aircraft. The head-mounted cameras consisted of a camera viewing the pilot's right eye through an infrared "hot" mirror, and a forward-looking scene camera located in front of the subject's forehead. From the eye images we compute estimates of head-relative gaze, while we obtain independent estimates of the head pose from the head-mounted scene camera and a stationary "face" camera. This talk will present an overview of the technical challenges encountered in the processing of the images, as well as preliminary results of the study.

Acknowledgemnts: Supported by FAA AAR-100, and the Airspace Operations Systems (AOS) project of NASA's Airspace Systems program.

Cognitive Errors in the Cockpit

Jessica Lang Nowinski, Jon B. Holbrook and R. Key Dismukes

ABSTRACT

Memory errors in the cockpit are often detected before they have negative consequences, but in a few tragic cases have led to major aviation disasters. Our view is that vulnerability to such errors is not an indication of lack of expertise, but rather a function of the way normal human memory processes operate in situations involving routine, well learned behaviors. Approximately 6% of a random sample of 1299 Aviation Safety Reporting System (ASRS) reports analyzed were found to describe memory failures by pilots. These 75 reports were categorized according to four themes: monitoring, absence of cues, habit capture, and poorly formed intentions. The cognitive mechanisms underlying these four types of memory errors are discussed as well as potential strategies for reducing vulnerability to errors.

Basic Research on Dual-task Performance Limitations

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** This research was supported by the Human Measures and Performance Project of NASA's Airspace Systems Program.

ABSTRACT

Human operators in domains critical to NASA (e.g., pilots, controllers) often need to perform multiple tasks concurrently. Unfortunately, human multi-tasking ability is subject to severe limitations. Understanding these limitations may lead to ways to overcome them through training, or work around them through task redesign. One well-established obstacle to human multi-tasking is a single-channel bottleneck in central cognitive processing. We explored several promising hypotheses about how this central bottleneck can be ameliorated. One hypothesis is that the central bottleneck is strategic and can be eliminated by sheer effort of will. A second hypothesis is that the central bottleneck can be diminished or even eliminated with optimal matching of output modalities to input modalities (e.g., vocal responses to auditory stimuli and manual responses to visual stimuli). A third hypothesis is that the central bottleneck can be eliminated with extensive practice. Our research shows the greatest potential gains from input/output matching and from practice. Implications for improving human multi-tasking in NASA operations through task design and training will be discussed.

Function Allocation and Operator Engagement

Paul Schutte
NASA Langley

ABSTRACT

Unlike machines, humans cannot be built to order by designers to perform specific tasks; at best they are trained to perform tasks but there are limits to training. Humans have a very strict operational envelope and require specific information in order to do their job. They are limited in memory, endurance, and other abilities such as computation. If the human is required to perform outside of this envelope or without sufficient information, they will fail. For example, a human who is asleep and is abruptly awoken to perform an assessment and decision making task quickly will more than likely perform it poorly. One reason is that human mental processes are usually sluggish on wakening from sleep. Another reason is that the human has been blissfully unaware of what has been going on in the surrounding world while asleep. Making assessments requires data and the human has not been acquiring data. In addition, humans respond very differently under time pressure and in some individuals, reasoning under time pressure is extremely difficult.

In the past, allocating tasks to the human or the automation has usually followed a Fitt's List approach where a task decomposition was performed on the mission and tasks were assigned to whomever could perform them best. There are several flaws in this process. The first assumes that humans can perform the task well in isolation – that is, without any context or involvement in other tasks. For example, humans are better at performing qualitative value judgments and pattern recognitions. However, if the automation has been assigned tasks that remove the human from the information used to make these assessments, then the human will be hampered in performing them. The second flaw in this argument is that the tasks that humans do better than machines are tasks that the human does well. This is often not the case. Often the tasks that humans do better than machines are difficult even for humans. Thus, the human is assigned the most difficult leftovers. This increases the likelihood that the human will make a mistake and will reduce the spirit or morale of the human, which will lead to even poorer performance. Yet another problem with traditional function allocation is that machines do routine and monotonous things very well and therefore they are often assigned these tasks. This would be good except it leaves the human with little to do and the human can become bored or complacent. Pilots often refer to hours of boredom punctuated by moments of terror.

For these reasons a new allocation strategy is required. This presentation will describe the allocation strategy currently being used for developing a flight deck for a personal air vehicle. It is based on the general role that the human is going to play in the mission (including the roles the human may be called on to play). The knowledge, control and information requirements are determined for performing these roles. The next step is to determine where the human is weak and can use some help. The machine is then designed around those needs. The reason for this approach is that humans are less 'designable' than machines. We can design a machine around a human but we cannot design a human around a machine. At best, we can train the human but that has its limits and is costly.

Analysis of the Human-Computer Interaction for Scratchpad Error Messages on the Flight Management System

Lance Sherry

ABSTRACT

Researchers have documented the difficulties airline pilots have learning and using all the features of the Flight Management System (FMS). These difficulties contribute to increased airline training costs, increased operational costs, and reduced margins of safety. The FMS error messages that are displayed in the scratchpad of the Multi-function Control and Display Unit (MCDU) have been observed to be one of the sources of confusion to airline pilots.

This paper describes an analysis of the human-computer interaction required to respond to the messages for an existing FMS. Almost one half of the messages (36 out of 67) occur less than once in every hundred flights. More than half of the messages (48 out of 67) require immediate pilot response. Messages that require immediate response and occur with such low frequency have implications for the design of the content of the messages to ensure robust human-computer interaction. Analysis of the human-computer interaction required to respond to each messages found that 38 (out of 67) messages rely on memorized action sequences to initiate a response. Without a visual cue in the content of the message to prompt the correct response, pilots will experience difficulty learning the correct response during training. Likewise the absence of the visual cues and the low frequency of occurrence, will result in a tendency for pilots to fail to recall the correct response to the message during line operations. Guidelines for the improved design of messages are discussed.

A Human in the Loop Simulation Assessment of an En Route Trajectory Negotiation Concept

Nancy Smith

ABSTRACT

Two integrated air ground simulations with commercial airline pilots and certified professional controllers were conducted at NASA Ames Research Center to evaluate a concept for en route air-ground trajectory negotiation. This concept was developed as part of the Distributed Air-Ground Traffic Management (DAG-TM) project, which explores use of new technology, including CPDLC and flight deck and ATC decision support tools (DSTs), to accommodate user preferred trajectories. The integrated simulation environment developed to support these evaluations included:

- an en route controller display with conflict prediction and a tool for altitude and route trial planning;
- time-based metering, with an interactive timeline and speed advisories for the controller;
- a cockpit display of traffic information (CDTI) with CD&R, RTA-conformance capability, and an embedded route assessment tool (RAT) for formulating trajectory requests;
- controller-pilot data link communication (CPDLC) integrated with ground automation to support transfer of communications, speed advisory and trial plan clearance uplinks, and trajectory request downlinks;
- automated dependent surveillance-broadcast (ADS-B) disseminating aircraft state and intent information.

We will present results, with a particular emphasis on the effectiveness of the integrated set of tools, displays and procedures. Integration of controller speed advisories and trial planning DSTs with automatic message formatting and an efficient interface for sending uplink clearances greatly enhanced the usability and effectiveness of both DSTs and CPDLC. Trajectory negotiation was supported and metering and route clearances were facilitated, with the consequence that most aircraft were flying FMS trajectories known to the ground automation. This ability to keep aircraft on 4-D trajectories improved the accuracy of ETAs and conflict predictions used to develop those trajectories. This integrated operational environment thus shows promise of providing more benefit than simply a sum of the contributions of each individual component.

Flight Path Marker Symbol for Rotorcraft Synthetic Vision Displays

Zoltan Szoboszlay

ABSTRACT

A new flight path marker symbol was developed at Ames Research Center for rotorcraft synthetic vision displays. Synthetic vision displays show an artificial image of the terrain on the pilot's primary flight display. The new flight path marker shows the predicted location of the aircraft with respect to the synthetic terrain at a set time or distance away. The unique elements added to the flight path marker are the predicted altitude above the terrain at the prediction point, as well as the predicted ground track. Large pilot-vehicle performance improvements in altitude and ground track control were recorded in simulation as compared to the traditional flight path marker. This display was also flown for the first time on the RASCAL UH-60 at Ames Research Center in July 2004.

Modeling Pilots' Use of Visual Cues for Active Control

Barbara T. Sweet, IHH
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We are developing models of pilots' use of visual cues for closed-loop manual control tasks. The techniques we employ combine aspects of manual control (i.e., human operator describing function identification) and psychophysical modeling. Specific tasks we have studied include: the control of longitudinal position; the control of pitch attitude; and the control of range (or depth). Our modeling procedure can be used to determine the specific cues or visual features in the scene that the pilot is using to accomplish the task.

The results of our studies show that the visual scene features that contribute to effective static spatial (position) perception are different than those that contribute to effective visual motion perception. Our results also demonstrate that the dynamics of the vehicle being controlled affect the pilots' information requirements (e.g., position versus motion). Further, the features in the scene can affect the quality of information available to accomplish the task. We demonstrate how the lack of effective visual motion cueing can lead to performance degradation.

In this talk, we will review the psychophysical and control modeling underpinnings of our approach and provide an overview of our integrative methodology. We will then present results from empirical studies. Finally, we will discuss the implications of our findings for the design of synthetic vision systems and flight simulators. Interested parties are invited to attend a demonstration of our experimental paradigm during the laboratory tours.

Anomaly Resolution

Irene Tollinger and Chris Connors

ABSTRACT

The Human Computer Interaction (HCI) Group in at Ames Research Center is conducting primary research in several anomaly resolution and investigation contexts aimed at establishing a baseline of current practices. Although the contexts and environments in which anomaly resolution takes place vary, the fundamental elements of the process appear to be consistent between contexts: assembly or notification of a group, the gathering of pertinent current and historical data, analysis and problem solving based on uncertain or incomplete information, decision making, and some information archiving. This work will feed into the development of improved anomaly support tools and processes based on an understanding of the goals, capabilities, and limitations of participants and stakeholders and a rich understanding of the context.

The Spatial Standard Observer and Aeronautics Applications

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ABSTRACT

Many aeronautical human factors problems are visual in nature. The Spatial Standard Observer was developed in response to a need for a simple, practical tool for measurement of visibility and discriminability of spatial patterns. The SSO is a highly simplified model of human spatial visual processing, implemented as a compact software tool. It is based on data collected in a large cooperative multi-lab project known as ModelFest. It incorporates a few essential components, such as a local contrast transformation, contrast sensitivity function, local masking mechanism, a local sensitivity window, and a mechanism for pooling over a scanned area. Among these applications are design of viewing systems for unmanned aerial vehicles, measuring visibility of damage to aircraft and to the shuttle orbiter, predicting outcomes of corrective laser eye surgery, and inspection of flat-panel liquid crystal displays during the manufacturing process. It may also be used to evaluate legibility of text, as well as discriminability of icons or symbols in a graphical user interface. In this talk we will describe the development of the SSO, and will describe in detail a number of these potential applications.

Effects of Procurement Type on Human Factors Activities

Daniel L. Welch, Ph.D., CPE
WAAS and LAAS Program Offices TAC

ABSTRACT

The Federal Aviation Administration (FAA) is currently developing two satellite-based navigation systems, the Wide Area Augmentation System (WAAS) and the Local Area Augmentation System (LAAS). This presentation will describe the differing natures of the two procurements and explore the resulting differences in the objectives, tasks, and procedures of the associated Human Factors (HF) programs.

For each system, the following topics will be covered briefly:

- an overview of the system and its operation,
- the major human interfaces of the system,
- the nature and status of the procurement,
- the important HE issues being addressed,
- the impact of procurement particulars on HF activities.

For the LAAS, discussion will center on two topics. First, the Government-Industry Partnership (GIP program, which preceded a more traditional system development contract, enabled a number of contractors to independently develop prototype LAAS's. These early prototype developments had a number of impacts on the developing interfaces, both positive and negative. The impact of the GIP on the current system will be examined. Second, the efforts of the FAA and the National Air Traffic Controllers Association (NATCA) to develop and test a concept interface for the Air Traffic Control Unit (a tower cab display) will be presented, along with results.

For the WAAS, the primary topic of discussion will be the nature of the HF program as art of the overall development effort. The WAAS has been operating since 1996 and was commissioned in 2003. In the current Full Operational Capability contract phase, an extensive HF review and enhancement effort is being undertaken. The process employed in that review, along with a number of exemplar enhancements, will be presented.

The total presentation will provide (1) an understanding of the WAAS and LAAS programs, (2) insight into the effects of different procurement and development approaches on HF activities, and (3) a discussion of the innovative ways in which differing requirements are being addressed by the FAA and the systems contractors.

Current Approaches to 3-D Sound Reproduction

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ABSTRACT

This paper will review current approaches to spatial sound synthesis. In general, different applications of virtual acoustic environments emphasize different aspects of the listening experience that require different approaches to rendering software/hardware. Auralization requires computationally intensive synthesis of the entire binaural room response that typically must be done off-line and/or with specialized hardware. A simpler simulation that emphasizes accurate control of the direct path, and perhaps a limited number of early reflections may be better suited to information display. The fact that such a simulation does not sound "real" may have little to do with the quality of directional information provided. Achieving both directional accuracy and presence in virtual reality applications requires that head tracking be enabled with special attention devoted to the dynamic response of the system. One solution for synthesizing interactive virtual audio has been the development of what might be termed hybrid systems. These systems attempt to reconcile the goals of directional accuracy and realism by implementing real-time processing of the direct path and early reflections using a model (e.g., the image model) combined with measured or modeled representations of late reflections and reverberation that remain static in response to head motion. Another recent trend is that in some spatial sound systems, synthesis is now being performed entirely in software for use on generic hardware platforms such as a personal computer with a Windows or Linux operating system

Most currently available virtual audio systems tend to fall into two categories. Those aimed at high-end simulations for research purposes (e.g., auralization, psychoacoustics, information displays, virtual reality) emphasize high-fidelity rendering of direct path and/or early reflections, accurate models of late reverberation, and good system dynamics (high update rate, low latency). Other systems are directed toward entertainment and game applications. The rendering algorithms in such systems are proprietary and appear to emphasize efficient reverberation modeling; it is often not clear whether the direct path and/or early reflections are independently spatialized.